Geophysical Research Abstracts
Vol. 16, EGU2014-8698, 2014
EGU General Assembly 2014

Energy deposition in the ionosphere derived from LEO satellite observations

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Ten years of successful operation of the multi-instrument CHAMP satellite mission at a unique orbit altitude of about 400 km revealed many interesting features of the coupling between the thermosphere and ionosphere. Different processes contribute to the deposition of solar and magnetospheric energy into the thermosphere. One important venue is heating through thermal electrons transferring energy by collisions with ions and neutrals. In the ionospheric F region thermal electrons are heated primarily through photoelectrons by local or non-local processes. At high latitudes soft precipitation and electromagnetic heating play a major role. The energy deposition can be quantified by a family of chemo-physical equations (Schunk and Nagy, 2009) that depend on plasma and neutral densities and temperatures. One important indicator for the energy transfer is the difference between electron and ion- and neutral- temperatures. Electron cooling leads to thermospheric heating and and we expect that this process leads to a local enhancement of mass density (air drag). Sizable electron cooling rates in the F region have been published from EISCAT radar observations in the ionospheric cusp. Based on CHAMP observation of electron density and temperature we estimate the energy deposit in the F-region through cooling of the thermal electron gas caused by elastic and inelastic processes. We find that a significant deposition is present during day at mid latitudes. At low latitudes the energy flux remains important until midnight. Observed heating rates depend on the satellite altitudes, but they are globally available from the CHAMP data. Missing observations in the CHAMP dataset, e.g., ion temperature, are derived from empirical models as IRI or MSIS. We investigate the global distribution of the electron cooling rate, we quantify the contributions of the different processes (equations) to the total energy transfer, e.g., depending on height, and we intend to compare our results with radar observations.

Our focus is to apply Swarm observations also including ion temperature. We are interested in evaluating possible improvements when using the new Swarm observations instead empirical model results. These activities are preceded by a validation study of the Swarm Level-1b data derived from the Langmuir probe, e.g., electron density and temperature against estimations from IRI. From this project we expect to quantify the quality of the accuracy of the Langmuir Probe data within 20 percent uncertainty.